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PATENT APPLICATION TRANSMITTAL LETTER

Inventor(s): Andreas Meyer and Jürgen Sommer
Title: PNEUMATIC VEHICLE TIRES
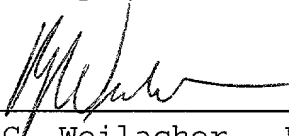Attorney Docket No.: 32238W020

Sir:

Transmitted herewith for filing are the following:

New patent application including 12 pages of text,
two sheets of drawings, unsigned Declaration,
Application transmittal, and no fees.

The filing fee, declaration and surcharge fee will
be filed in due course.

Respectfully submitted,

By _____
Robert G. Weilacher - Reg. No. 20531

PNEUMATIC VEHICLE TIRE

Introduction and Background

The present invention pertains to a pneumatic vehicle tire of the radial type with a

5   tread strip, which has a width defined as the tread width TW, which represents its

maximal width in the ground contact area in the case of mounted, loaded and inflated

tires, where, when viewed in cross section, the outer contour of the tread strip has at least

three different radii over its width TW, of which the first radius TR_1 extends over an area

encompassing the zenith of the tire, while an adjoining area on both sides of this area has

10   a radius TR_2, which is smaller than the radius TR_1, and while on each side of this area an

adjoining area has a radius TRA, which is smaller than the radius TR_1 of the area

encompassing the zenith of the tire.

It is known that tires with their outer contour designed with only one radius,

especially when these tires are provided with a low cross section, have a nonuniform

15   pressure distribution in the ground contact area. Above all, the contact pressure is often

elevated in the shoulder areas of such tires. This elevated contact pressure in the shoulder

areas negatively affects not only tire noise but also other tire characteristics, such as

braking behavior, stability at higher speeds, rolling resistance and the hydroplaning

characteristics.

20   In order to solve this problem, it has already been proposed that the outer contour

of the tire be designed with several variable radii in the area of the tread strip. It is known,

e.g., that two radii can be provided with the one extending over the an area of the width

of the tread strip encompassing the zenith of the tire and areas adjoining this on both

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sides and extending to the shoulder areas of the tire, which are provided with the second

radius. Numerous patent applications pertain to the optimization of such a 2-radii

contour, e.g., EP-A 0 269 301 proposes that the size of the radii be established in relation

to the cross-sectional width of the tire. Here the one area of the outer contour

5   encompassing the zenith of the tire is provided with a radius selected to be between 1.5

and 2.5 times the maximal width of the tire mounted on a rim and inflated; the second

radius should be greater than the first radius, especially 1.5-2.5 times the first radius.

EP-B 0 323 519 also pertains to an equalization of the contact pressure of the tire

in the ground contact area in order to prevent nonuniform wear and improve wet gripping

and driving comfort. In this patent as well a 2-radii contour is selected for the outer

contour of the tread strip and the arrangement of the sidewalls is set in certain

relationships to the conditions existing between the running surface radii and the

maximum tire width.

A pneumatic vehicle tire of the type described in the introduction, the outer

15   contour of which is designed with three different radii is known from EP-A 0 850 788.

Here, in addition to an optimization of the belted plies to reduce tire weight, improved

tire performance and driving comfort is of concern. To this end, the outer contour of the

tire in the tread strip area is combined with three different radii and with a variable

number of belted plies.

20   With a 2-radii contour or a 3-radii contour, as known heretofore, it is indeed

possible to achieve certain improvements in the pressure distribution in the ground

contact area; however, even with complementary optimization of diverse parameters, it is

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not possible to influence the pressure distribution in the ground contact area of the tire to the desired extent or in desired manner.

Accordingly, an object of the invention, with a tire of the type described above and by way of optimization of the configuration of the outer contour of the tread strip area, is to increase the possibility of being able to control better than heretofore the pressure distribution in the ground contact area, in order to be able to influence deliberately certain characteristics of the tire, such as braking behavior, handling, noise development, and the like.

Summary of Invention

The aforementioned and other objects can be achieved according to the invention in that in each case the margins of the tread strip defined by the tread width TW run in a fourth radius, a shoulder radius provided in the transition area to the sidewalls of the tire, so that the size of the radius TRA is derived according to the equation $0.05\ TR_1 \leq TRA \leq 0.65\ TR_1$ in that the radius TR_2 is either less than or greater than the radius TRA, where, for the case when $TR_2 \leq TRA$, the size of the radius (TR_2) is defined by the equation $0.05\ TR_1 \leq TR_2 \leq 0.6\ TR_1$ and for the case when $TR_2 \geq TRA$, the size of the radius (TR_2) is defined by the equation $0.1\ TR_1 \leq TR_2 \leq 0.05\ TR_1$.

Consequently, according to the present invention the outer contour of the tread strip is so designed that it consists of an area with four different radii. This fundamentally permits a much better exercise of influence on the pressure distribution in the ground contact area. As has been shown, the interrelationship of the size of the individual radii is also significant for a equalization of the pressure distribution, especially the

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aforementioned relationship between the radius in the area encompassing the zenith of the tire and the radius of the radially outermost areas. Specifically, it is the last radius that makes it possible to exert influence on the volume in the shoulder areas outside the contact area. For example, with a relatively large radius in these areas a decrease of the volume in the shoulder areas outside the contact area is achieved. The rounder dynamic contour thus realized results in a lower temperature development in the tire and therefore an improved high-speed stability. The achievable uniformity of the pressure distribution has positive effects on various tire characteristics, such as braking behavior, handling and noise development.

In many cases of the structural design of a tire according to the invention, a uniform pressure distribution in the ground contact area can be realized when $TR_2 <$ TRA. However, depending upon the contour specifications and the structural configuration of the tire, other relationships and conditions for a uniform pressure distribution and an optimal diminution of the pressure in the shoulder areas can also be advantageous here and $TR_2 >$ TRA can prevail.

The desired rounder dynamic contour of the tire is especially well achieved when the size of the radius TRA is determined according to the equation

$$015 \le TRA \le 0.05\ TR_1.$$

For the case when $TR_2 >$ TRA, it is especially advantageous if the size of TR_2 is determined according to the equation

$$0.6\ TR_1 \le TR_2 \le 0.95\ TR_1.$$

For the desired characteristics improvement or the extent of the influence exercised on the pressure distribution in the ground contact area of the tire, it is important

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how the size of the individual radii is determined or selected. Specifically, the radius TR_1

should be determined according to the equation

$3\ TW \le TR1 \le 25\ TW$, especially

$3\ TW \le TR_1 \le 6\ TW$.

5   The width of the areas with the three different radii also has a certain significance.

In this respect, it is favorable when the area that includes the zenith of the tire with the

radius TR_1, which is delimited by a distance TW_1 between two points that are

symmetrical about the zenith of the tire, is so designed that TW_1 satisfies the equation

$0.1\ TW \le TW_1 \le 0.7\ TW$.

10   The area adjoining the zenith of the tire with the radius TR_2 extends especially to

two points in the outer contour that are symmetrical about the zenith of the tire, the

distance TW_2 between which points is determined by the equation

$0.15\ TW \le TW_2 \le 0.9\ TW$.

The transition to the shoulder radius on each side ensues at a distance (RA) from

the edges of the tread strip, which is between 1.5 and 14%, especially between 3 and

15   10%, of the tread width TW.

Brief Description of Invention

Further characteristics, advantages and details of the invention are described at

20   greater length with references to the appended drawings. The two figures of the drawing

are schematic illustrations, where Figure 1 depicts a cross section through a pneumatic

vehicle tire designed according to the invention and Figure 2 depicts only the trace of the

outer contour and the trace of the inner contour of the tire in Figure 1.

Detailed Description of Invention

The depicted and described embodiment example pertains to a tire for an automobile. The invention is not, however, restricted to this type of tire and can just as easily be applied to other types of tires, e.g., truck tires.

The pneumatic vehicle tire shown in Figure 1 is mounted on a merely indicated rim 10 and includes a tread strip 1, which is provided with a tread pattern, on which peripheral grooves (2) are depicted. The tread strip 1 runs laterally into the shoulder areas of the tire and is therefore wider than the tread width TW shown in Figure 1. The tread width TW is the greatest width of the tire imprint (also called the contact area) on the ground when the tire is mounted on a suitable rim and placed under nominal pressure and nominal load. The illustrated peripheral grooves (2) extend to the preplanned maximum profile depth, which in general is chosen to be 7-8 mm. Other profile structures, e.g., grooves running in the transverse direction, can also be provided, which, except for a trace becoming flatter into the shoulder areas, usually extend to the maximum profile depth. The groove base of these profile structures is delimited over the circumference of the tire by an envelope, of which the outline (1a) is shown in Figures 1 and 2 and which is described as the inner contour.

Provided radially inside the tread strip 1 is a belted band 3, which in the embodiment form shown in Figure 1 has two ply layers 3a, 3b, of which the radially inner ply layer 3b is wider. The two ply layers 3a, 3b can be built up in the usual style and manner, e.g., consisting in each case of steel cords embedded in a rubber matrix and running parallel inside each layer. The complementary arrangement of both ply layers 3a,

3b or of the steed cords in the ply layers 3a, 3b is normally such that between the steel

cords of the one layer and the steel cords of the other layer a crossed arrangement exists.

The tire shown by way of example in Figure 1 is also provided with a single-layer

radial carcass 4, which in both bead areas 5 extends from the inside outward over bead

5   cores 6 and back into the sidewalls 7, where the carcass 4 ends in the sidewalls 7 in each

instance at a separation from the upper end areas of the core profiles 8.

According to the present invention, the outer contour of the tire is specially

designed in the tread strip area, especially in order that a uniform pressure distribution

can be at least extensively achieved in the ground contact area of the tire. To this end, the

10   outer contour encompasses areas with three different radii TR_1, TR_2 and TRA.

As is shown in Figure 1 in conjunction with Figure 2, the tire mounted on the rim

10 and inflated has in the tread strip an area encompassing the zenith of the tire, which is

identified in the drawings by the point P_0, with the radius TR_1. This area extends on both

sides from the point P_0 to the points P_1, which lie symmetrically to the point P_0. Thus the

15   radius TR_1 extends over an area of the outer contour defined by the separation TW_1

between both points P_1. For TW_1 the equation (1) $0.1\,TW \le TW_1 \le 0.7\,TW$ applies.

The areas with the second radius TR_2 adjoin on both sides the area with the radius

TR_1, where the transitions are selected to be not abrupt but rather gentle. The areas of the

outer contour with the radius TR_2 extend on both sides between the points P_1 and the

20   points P_2. The distance TW_2 between the two points P_2 is selected according to the

equation (2) $0.15\,TW \le TW_2 \le 0.9\,TW$.

The area with the third radius TRA is on both sides between the points P_2 and yet

another point P_3 which in the outer contour of the tread strip defines the transition to a

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shoulder radius SR. The location of the points (P_3) is here axially inside the greatest tread width TW, indeed at a distance RA of 1.5-14% of the tread width TW.

Of special significance in achieving a uniform pressure distribution in the ground contact area of the tire is the complementary relationship of the radii TR_1, TR_2 and TRA. Especially applicable is $TR_1 > TR_2$ and $TRA < TR_1$.

The value of TR_1 is determined by the following equation (3) $3\ TW \le TR_1 \le 26\ TW$, especially $3\ TW \le TR_1 \le 6\ TW$. For determining the value of TRA, the following equation is used (4) $0.05\ TR_1 \le TRA \le 0.65\ TR_1$, especially $0.15\ TR_1 \le TRA \le 0.65\ TR_1$. The value of TR_2 depends upon the other contour projections and the structural configuration of the tire, while the standard case thereof is $TR_2 \le TRA$ and $TR_2 < TR_1$, while the value of TR_2 can be determined by the equation (5) $0.05\ TR_1 \le TR_2 \le 0.6\ TR_1$.

In the case of certain projections, it is advantageous in achieving an optimal diminution of the pressure in the shoulder areas when $TR_2 > TRA$ and the value of TR_2 is selected according to the equation (6) $0.1\ TR_1 \le TR_2 \le 0.95\ TR_1$, especially $0.6\ TR_1 \le TR_2 \le 0.95\ TR_1$

In each instance, the outer contour is so configured that $TRA \le TR_1$. In order to reduce the pressure in the shoulder areas in order to achieve a uniform pressure distribution, TRA is nevertheless selected to be relatively great, so that the positive volume of the tread strip in the shoulder areas is also reduced outside the driving surface determined by the tread width TW. The rounder dynamic contour of the tread strip achievable according to the present invention also results in a lower temperature development during tire use. Due to the reduced shoulder pressure, high-speed stability is improved, as well as the durability of the tire. As already repeatedly noted, a uniform

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pressure distribution in the ground contact area of the tire is achieved with a design of the outer contour carried out according to the present invention. Just such a uniform pressure distribution has positive effects on the braking behavior, on the handling behavior and also on the noise development during operation.

5   Outer contours configured according to the present invention can also encompass more than three radii, where in the equations cited above, TRA is that radius that determines the contour of the two outermost areas. For example, an outer contour can consist of areas with four different radii.

The desired outer contour according to the invention is imparted to the tire by way of a comparable configuration of the inner contour of the segments of the vulcanization mold forming the tread strip area. The vulcanized tire mounted on a rim and inflated to a specified pressure has a congruous, at least essentially congruous, outer contour.

Further variations and modifications will be apparent to those skilled in the art from the foregoing and are intended to be encompassed by the claims appended hereto.

German application 195 45 774.3 is relied on and incorporated herein by reference.

<u>Claims</u>

1. Pneumatic vehicle tire with a tread strip, which has a width defined as the tread width TW, which represents its maximum width in the ground contact area in the case of mounted, loaded and inflated tires, where, when viewed in cross section, the outer contour of the tread strip has at least three different radii over its width TW, of which the first radius TR_1 extends over an area encompassing the zenith of the tire, while an adjoining area on both sides of this area has a radius TR_2, which is smaller than the radius TR_1, and while on each side of this area an adjoining area has a radius TRA, which is smaller than the radius TR_1 of the area encompassing the zenith of the tire, wherein each case the edges of the tread strip defined by the tread width TW run in an area with a fourth radius, a shoulder radius provided in the transition area to the sidewalls of the tire, in that the size of the radius TRA is determined according to the equation $0.05\ TR_1 \le TRA \le 0.65\ TR_1$, in that the radius TR_2 is either smaller or greater than the radius TRA, where, for the case $TR_2 \le TRA$, the size of the radius TR_2 is determined according to the equation $0.05\ TR_1 \le TR_2 \le 0.6\ TR_1$ and for the case $TR_2 > TRA$, the size of the radius TR_2 is determined according to the equation $0.1\ TR_1 \le TR_2 \le 0.95\ TR_1$.

2. Pneumatic vehicle tire according to Claim 1, wherein the radius TRA is determined according to the equation $015 < TRA < TR_1$.

3. Pneumatic vehicle tire according to Claim 1 wherein for the case $TR_2 > RA$ the size of the radius TR_2 is determined according to the equation $0.6\ TR_1 \le TR_2 \le 0.95\ TR_1$.

4. Pneumatic vehicle tire according to Claim 1, wherein the radius TR_1 is determined according to the equation $3\ TW \le TR_1 \le 25\ TW$, especially according to the equation $3\ TW \le TR_1 \le 6\ TW$.

5. Pneumatic vehicle tire according to Claim 1 wherein the area with the radius TR_1 and encompassing the zenith of the tire is determined by a separation TW_1 between two points that are symmetrical about the zenith of the tire, where the separation TW_1 is determined according to the equation $0.1 \, TW \leq TW_1 \leq 0.7 \, TW$.

6. Pneumatic vehicle tire according to Claim 1, wherein each area with the radius TR_2 extends to two points in the outer contour that are symmetrical about the zenith of the tire, the distance TW_2 between which points is determined by the equation $0.15 \, TW \leq TW_2 \leq 0.9 \, TW$.

7. Pneumatic vehicle tire according to Claim 1, wherein each case the transition to the shoulder radius takes place at a distance RA from the edges of the tread strip, which is 1.5-14%, especially 3-10%, of the tread width TW.

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Abstract

A pneumatic vehicle tire of the radial type with a tread strip, which has a width defined as the tread width TW, which represents its maximal width in the ground contact area in the case of mounted, loaded and inflated tires, where, when viewed in cross section, the outer contour of the tread strip has at least three different radii over its width TW, of which the first radius TR_1 extends over an area encompassing the zenith of the tire, while an adjoining area on both sides of this area has a radius TR_2, which is smaller than the radius TR_1, and while on each side of this area an adjoining area has a radius TRA, which is smaller than the radius TR_1 of the area encompassing the zenith of the tire. In each case, the edges of the tread strip defined by the tread width TW run in an area with a fourth radius, a shoulder radius provided in the transition area to the sidewalls of the tire. The radius TRA is determined according to the equation $0.05\ TR_1 \leq TRA \leq 0.65\ TR_1$. The radius TR_2 can be either less than or greater than the radius TRA, where, for the case $TR_2 \leq TRA$, the radius TR_2 is determined according to the equation $0.05\ TR_1 \leq TR_2 \leq 0.6\ TR_1$, and, for the case $TR_2 \geq TRA$, the radius TR_2 is determined according to the equation $0.1\ TR_1 \leq TR_2 \leq 0.95\ TR_1$.
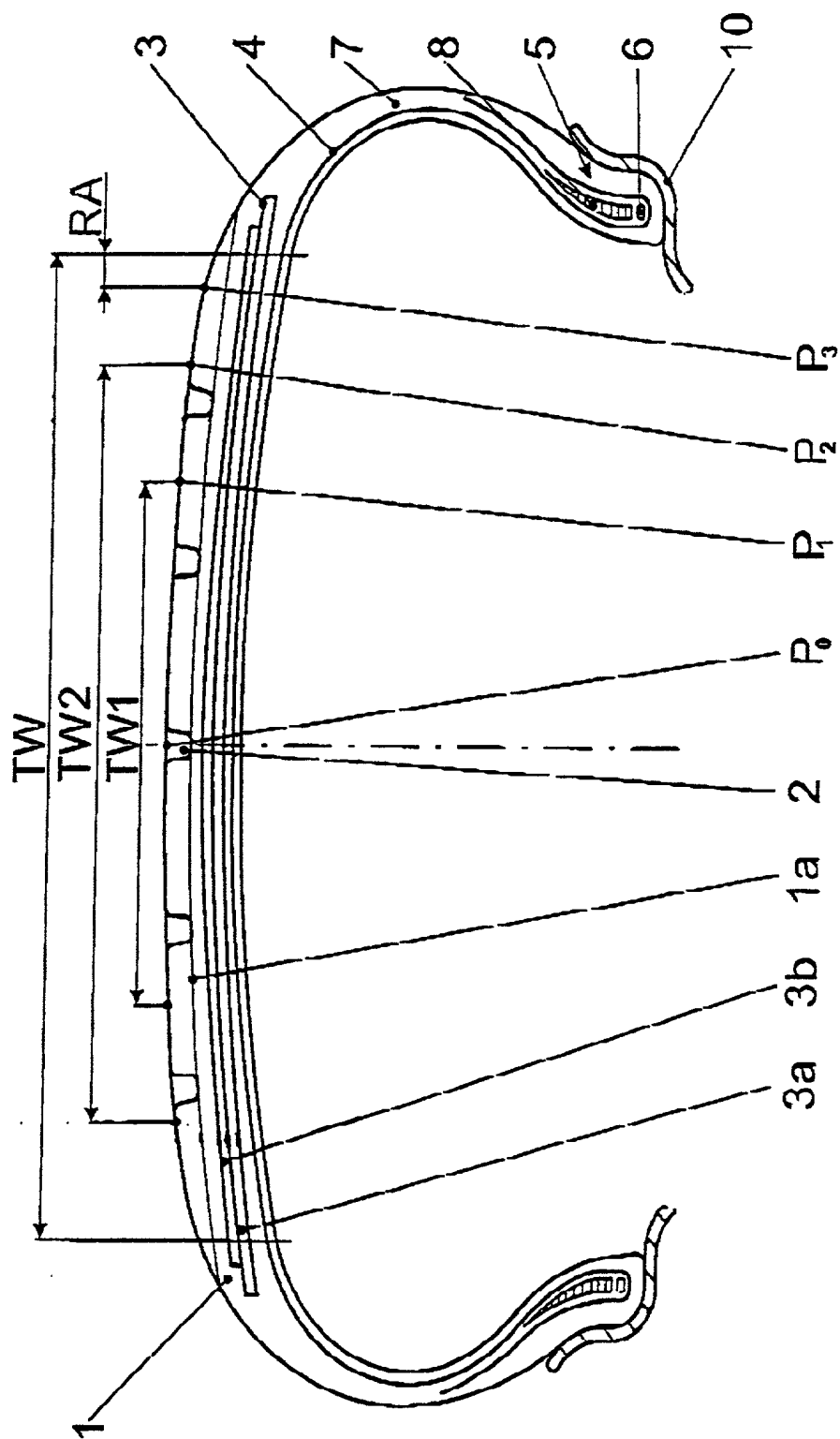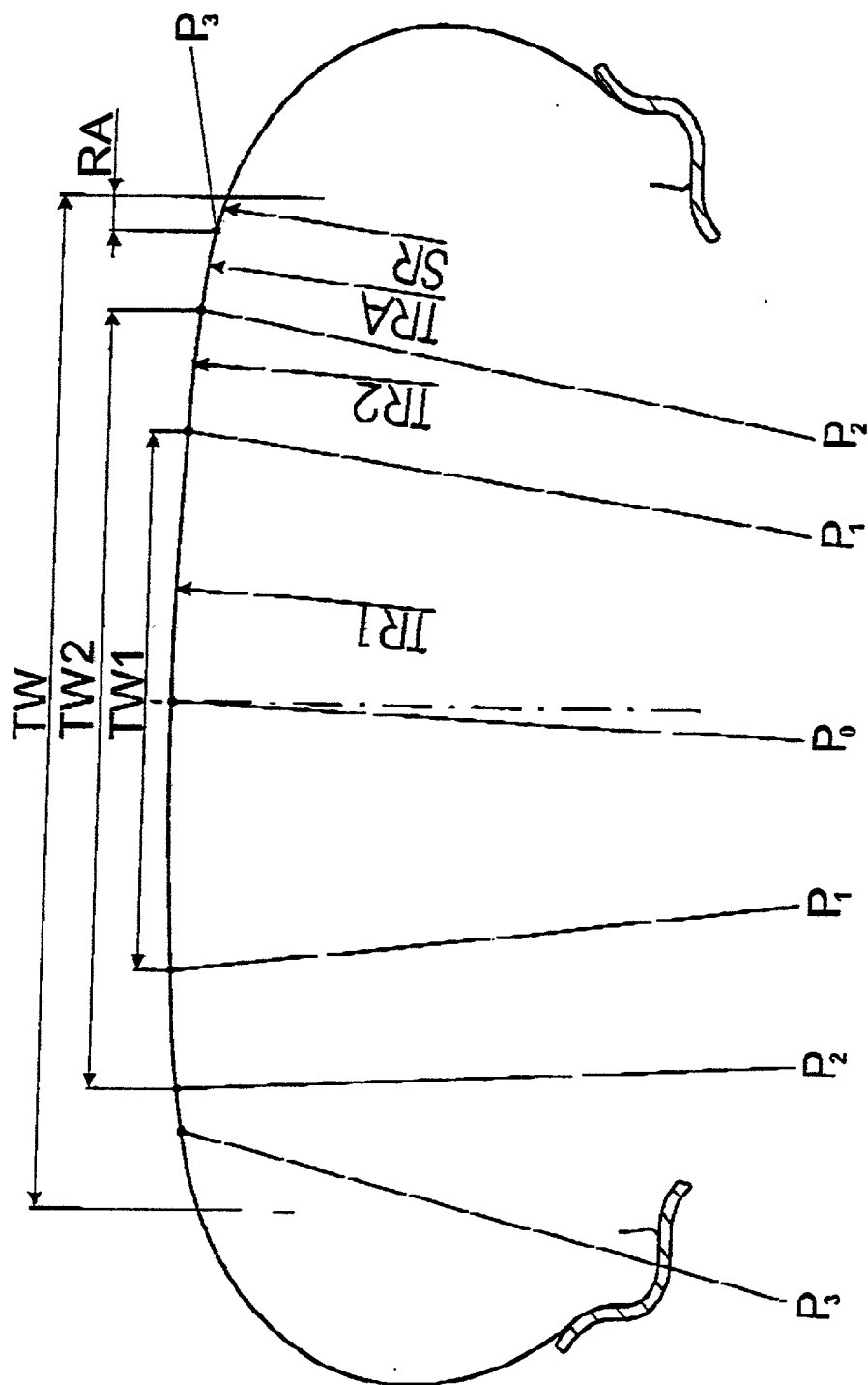
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Fig. 1

Fig. 2

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Declaration and Power of Attorney
United States Patent Application.

As a below named inventor, I hereby declare that:
My residence, post office address and citizenship are as stated below next to my name.
I believe I am the original, first and sole inventor *(if only one name is listed below)* or an original, first and joint
inventor *(if plural names are listed below)* of the subject matter which is claimed and for which a patent is sought on
the invention entitled: PNEUMATIC VEHICLE TIRES

(check one)   ☒ is attached hereto.
           ☐ was filed as U.S. Application No._____ on_____ and *(if applicable)* was amended on_____ .
           ☐ was filed as PCT International Application No._____ on_____and *(if applicable)* was amended
               under PCT Article 34 on _____ .
               (I authorize any attorney appointed below to insert information in the preceding blanks.)

I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.
I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) or §365(b) of any foreign and PCT application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States of America listed in this Declaration. I have also identified below any foreign application for patent or inventor's certificate or PCT international application having a filing date before that of the application(s) on which priority is claimed:

Foreign/PCT Application No.	Country	Filing Date	Priority Claimed? (yes/no)
199 45 774.3	German	24 September 1999	YES

I hereby claim the benefit under Title 35, United States Code, §120 or §365(c) of any United States application and PCT international application designating the United States of America listed in this Declaration and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application or PCT international application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

U.S. Application No.	Filing Date	*Status (patented/pending/abandoned?)*

I hereby claim priority benefits under Title 35 United States Code §119(e) of any U.S. provisional application(s) listed below:

U.S. Provisional Application No.	Filing Date

I hereby appoint the following attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: Robert G. Weilacher (20,531), Herbert M. Hanegan (25,682), Frederick F. Calvetti (28,557), J. Rodgers Lunsford, III (29,405), Michael A. Makuch (32,263), Dennis C. Rodgers (32,936), William F. Rauchholz (34,701), Michael C. Carrier (42,391), Eric J. Hanson (44,738), Patrick R. Delaney (45,338) , Donna D. King (45,962) and Joseph M. Lewinski (46,383).

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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☐ Additional inventors and/or prior applications are listed in attached Supplemental Sheet(s).
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